A PRELIMINARY EVALUATION OF THE ACID-SULFITE PRESERVATION OF PIGSKIN

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Abstract

Pigskin, as a raw material for making leather in the United States, could become a future resource for our allied hide and leather industries. Therefore, our laboratory decided to make a preliminary evaluation to determine how effectively pigskin could be preserved by the acid-sulfite process developed at this Center. Small-scale studies indicated that pigskin samples treated with a 20 percent float of 1 percent sodium bisulfite and 1 percent acetic acid could be preserved for 28 days at 30°C based on control of microbial numbers and protease activity. The treated samples could also be drained of the treatment solution and stored for 28 days with no apparent change in preservation characteristics. In addition, samples of pigskin exposed to the SO_2 evolved from 1 percent $NaHSO_3$ (0.66 percent SO_2), based on sample weight, and stored at 30°C were also preserved satisfactorily for 28 days.

Fresh-pulled pigskins (butcher hogs) treated by the above acid-sulfite method, and then drained of excess treatment solution and stored at ambient temperatures of 21°C, were satisfactorily preserved for 13 days. These skins were then processed into leather that was comparable to the leather made from brined pigskins.

Introduction

Pigskins were formerly processed into leather almost exclusively in Eastern Europe and China. Now there is an increasing interest in the United States in the utilization of domestic pigskins as a raw material for making leather. Initially this interest was attributed to an enormous increase in the cost of conventional raw materials such as cattlehides and calfskins. Although this is no longer the case, some interest has been maintained in pigskin because of the future need for leather which, by the year 2000, could result in a shortfall of 3 billion square feet per year in world markets. In the United States alone this shortfall could reach

*Agricultural Research Service, U.S. Department of Agriculture.

350 million square feet. Many tanners are reportedly experimenting with pigskins. They are finding that, although it makes a suitable leather, it also poses certain problems not faced in producing side, split, and sheepskin leather (1, 2).

Knaflic *et al.* (3) stated that one reason for the lack of interest in the United States in pigskin for leather production was that the skin could be left on the carcass when the meat is sold. Modern selling and packaging methods now make it convenient to remove all the skin from the meat. Thus when the demand for pigskins increases and the leather industry can offer producers a reasonable price for them, substantially larger quantities can be made available for leather production. Various industry groups should now be coordinating their interest in the utilization of these skins.

A 1981 report on pigskins in leather (4) stated that only about half of the 5 million pigskins available were being processed in the United States. Slaughter could run as high as 95 million head which indicates that supply would be no problem. According to this report, interest in United States pigskins and pigskin leather was increasing faster overseas than in this country, with a good market developing in Western Europe. South America is also considered a potential market for United States pigskin leather. Presently, the Orient is making a bid for this latter market and could become a strong competitor for world markets overall.

The potential for pigskin use in leather has focused attention on the fact that most traditional methods of skinning pigs in the United States involve scalding to remove the bristles. This practice results in a skin that is considered all but useless for making grain leather. Various other methods of skinning are now under investigation which could result in an ample supply of pulled, brine-cured pigskins for domestic consumption. The subject of pigskins as a raw material for making leather has been comprehensively covered recently in a report by Feairheller, Bailey, and Maire (5).

Since pigskin is likely to become a new resource for the future allied hide and leather industries, it was decided to do some preliminary work to determine how effectively it is preserved by the acid sulfite method developed at this Center (6). This report presents the results that were obtained from these tests.

Materials and Methods

Laboratory Studies

In the first experiment, pigskin samples were exposed overnight to the sulfur dioxide evolved from an acid solution containing 1 percent sodium bisulfite based on the sample weight.* Bakers' Analyzed Reagent† contains 66.3 percent sulfur

* Caution must be exercised with acid solutions containing sulfite salts because of the evolution of SO_2, a toxic and irritating gas.

† Reference to brand or firm name does not constitute endorsement by the U.S. Department of Agriculture over others of a similar nature not mentioned.

dioxide by assay. In the text that follows, the concentration of sodium bisulfite used to evolve sulfur dioxide is followed by a percentage figure in parentheses, e.g., 1 percent $NaHSO_3$ (0.66 percent). The parenthetical value indicates the theoretical maximum amount of sulfur dioxide available (in this case, 0.66 percent).

The sulfur dioxide was generated by adding sodium bisulfite to a solution of 1 volume of concentrated sulfuric acid (96.3 percent) plus 2 volumes of water contained in a 50-ml Erlenmeyer flask placed in the treatment vessel. The solution was used in the proportion of 2 ml per gram of $NaHSO_3$ added.

Hide samples were treated in desiccators (250 mm ID). Plastic racks were constructed to fit into the desiccators and the hide samples were draped over supporting rods on these racks. The sodium bisulfite was added to the acid solution through a long-stemmed funnel and the desiccator was sealed. After the samples had been exposed to the sulfur dioxide for the prescribed time, they were transferred to Mason jars which were sealed and held in storage at 30°C. A doubled piece of Saran wrap was placed between the lid liners and jars to prevent corrosion of the liners.

In the second experiment, the samples of pigskin were treated with a 20 percent water float containing 1 percent sodium bisulfite, 1 percent acetic acid, and 0.03 percent Tergitol 15-S-9 (concentrations based on sample weight). The treatment was carried out in 1-qt Mason jars which were agitated intermittently (15-min on/off cycle) for 2 hr at approximately 200 rpm on a rotary shaker. Half the samples were drained for about 1 min and then transferred to separate jars for storage at 30°C. The remaining samples were stored in the treatment float at 30°C.

In this preliminary study, it was assumed that successful preservation of samples held for 28 days at 30°C would be likely to assure a 7- to 14 day storage of whole pigskins in larger-scale tests.

Large-Scale Tests

Three fresh frozen pigskins from butcher hogs were thawed by soaking them overnight in water. These skins had been removed from the animal by pulling. The skins were fleshed twice and then treated with a 20 percent float containing 1 percent of both sodium bisulfite and acetic acid based on the weight of skins. The treatment was applied by tumbling at 2 rpm for 2 hr in a stainless steel lined drum. The float was drained off and the skins were transferred to plastic bags which were sealed. The sealed bags were placed in a covered fiberglass box and, in this study, were held for 13 days at ambient temperatures of approximately 21°C. The skins were then processed to the crust stage and compared to crust leather prepared from brine-cured controls.

Analytical Methodology and Physical Testing

Microbial counts were determined by adding 500 ml of sterile water to sample

jars and shaking the jars for 15 min on a reciprocating shaker at approximately 200 rpm. The standard plate count was carried out with serial dilutions from the wash solutions. Samples from each dilution were plated in duplicate using standard plate count agar as the media. The plates were counted after 72-hr incubation at 30°C. The pH of the 500-ml solution used for bacterial count was determined and is referred to as the pH of the bacterial wash solution.

When the treated skins were tested for microbial counts, three samples were cut from the edges. When possible, one sample was taken from a top, exposed surface of the skin, another from the interior of the folds, and a third from a bottom location of the stored skin. Unless noted otherwise, these samples were used as a composite sample and assayed for microbial numbers.

Skin samples and skins were also tested for the presence of proteolytic enzyme activity in the juice pressed from them following a method developed by Rolf R. Schmitt and Clara Deasy to examine brined hides for delayed cure. This is referred to as the 1-hr gelatin film activity (GFA) (7,8).

The experimental leathers were tested for tensile strength (9), double hole stitch tears (10), and the SATRA grain crack (11, 12). This latter test followed the methods of the International Union of Leather Chemists' Societies where it is called the "Ball Burst Test." A SATRA extension at grain crack of 7 mm or more should give a leather satisfactory for lasting in most cases. A result less than 6 mm indicates that the leather is unsuitable for lasting. The leathers were given a subjective evaluation and samples of the leather were also subjected to a 3-min boil to test their resistance to shrink under these conditions.

TABLE I
TEST RESULTS ON THE EFFECTIVENESS OF BOTH SO_2 AND THE ACETIC ACID-SULFITE TREATMENT IN PRESERVING PIGSKIN SAMPLES STORED AT 30°C. (LABORATORY STUDIES)

	Bacterial wash		1-hr GFA
	pH	Bacteria	
		g/skin	
Treated samples after storage for 7, 14, and 28 days			
0.66% SO_2[a]	3.3-3.6	<1000	--[b]
1% HAc, 1% $NaHSO_3$, 20% float[c]			
Drained	4.2-4.5	<1000	0
Stored in float	4.1-4.4	<1000	0
Untreated samples			
Initially	6.6	24.8×10^6	
After storage for 4 days	--	--[d,e]	--[d]

[a] SO_2 generated from 1% $NaHSO_3$ based on skin weight.
[b] GFA test could not be run; sample pressings a thick paste of fat.
[c] After treatment for 2 hr, at 2 rpm, half the samples were stored in the float, the rest were drained for 1 min before storage.
[d] Samples too putrid to run.
[e] Visible bacterial growth.

Results

Table I lists the results of the small-scale preservation experiments. The samples of pigskins were tested for microbial counts, a 1-hr GFA, and bacterial wash pH's periodically as noted until the experiment was terminated after 28 days. All the methods of preservation tested were equally effective in reducing the microbial numbers originally present on the samples and maintaining excellent control of microbial numbers over the 28-day storage period. Those samples that were drained of treatment solution before storage at 30°C gave similar microbial counts, wash pH's, and 1-hr GFA tests as the samples that were stored in the treatment float. In the case of the SO_2-treated samples, a 1-hr GFA test could not be satisfactorily carried out because the samples gave a solid exudate of fat after pressing.

TABLE II

PHYSICAL TEST DATA ON CRUST LEATHER PREPARED FROM PIGSKIN SIDES PRESERVED BY ACID-SULFITE TREATMENT OR BY BRINE CURING (LARGE SCALE STUDIES)

	Elongation and strength			SATRA Grain Crack	Stitch Tear, Double Hole
Side No.[a]	Direction[b]	Elongation	Tensile strength	Extension	Stitch Tear
		%	psi	%	lb/in
Acid-sulfite treatment[c]					
1	Par	34.75	1528	13.06	426
	Per	17.50	1929		
2	Par	41.00	1656	12.93	444
	Per	22.88	1655		
3	Par	31.25	2135	11.64	587
	Per	20.25	1513		
4	Par	38.50	1660	12.31	543
	Per	23.00	1836		
Brine-cured					
5	Par	21.62	1789	11.21	533
	Per	26.63	1455		
6	Par	38.75	1362	12.49	362
	Per	33.75	1544		
7	Par	39.63	1857	11.84	587
	Per	33.75	2291		
8	Par	32.13	2217	11.44	603
	Per	28.38	1652	11.44	603

[a] Sides 1 and 2 are the right and left sides, respectively, of the same skin; likewise 3 and 4 of another skin. Sides 5 to 8 are all left sides, each from a separate skin.

[b] Par = parallel to the backbone; per = perpendicular to the backbone.

[c] Float of 20 percent water, 1 percent of both HAc and $NaHSO_3$, all based on skin weight. Drum at 2 rpm for 2 hr, drain and store at 21°C.

In the larger-scale tests conducted on pigskins, it was decided to treat the sides with a 20 percent float containing 1 percent $NaHSO_3$ and 1 percent acetic acid, and then drain the skins before storage as described in the Materials and Methods Section. After 13 days storage at ambient temperatures (21°C), the sides were sampled to test for microbial counts and protease activity. The bacterial counts were <1000 bacteria/gram on all the samples tested and the 1-hr GFA tests were all zero indicating no detectable proteolytic activity. The bacterial wash pH's were all in the range of 4.1 to 4.2. These results demonstrate excellent control of microbial numbers and protease activity and corroborate the results obtained in the small-scale studies.

These sides were tanned to the crust stage, and the leathers were judged to be comparable to corresponding pigskin crust leather controls made from brined sides. The physical properties of the experimental (Nos. 1 to 4) and control (Nos. 5 to 8) leathers are shown in Table II.

The tensile values, SATRA extensions, and the double hole stitch tear values of the experimental leathers are comparable to those obtained on leather made from brined sides. Samples taken from the experimental leathers also withstood a 3-min boil.

Conclusions

Fresh pigskin samples that were treated with an acid-sulfite solution and stored at 30°C were preserved satisfactorily for 28 days based on microbial counts and negative protease tests. Results were similar whether the samples were stored in the treatment solution or drained of the solution before storage. In additional small-scale studies it was shown that pigskin samples that were exposed to the SO_2 evolved from 1 percent $NaHSO_3$ (0.66 percent SO_2) and then stored at 30°C were also preserved for 28 days.

In a larger-scale study, whole pigskins that were treated with an acid-sulfite solution and then drained of the solution before storage at 21°C were preserved for 13 days. The leathers prepared from the pigskins which were preserved with the acid-sulfite treatment were comparable to the leathers prepared from brined pigskins, based on our subjective evaluation and the tensile, SATRA, and double hole stitch tear values. The antioxidant effect of the sulfite ion may offer additional benefits by inhibiting the breakdown of the fat in pigskins, and this could be important in maintaining the quality of the skins during storage (13).

Acknowledgments

The authors wish to thank Paula Civitillo and Bohdan Artymyshyn of our Laboratory for their assistance in this study.

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